RunNTM User's Guide

by

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Introduction

When generating a loads document for a wind turbine, one usually needs to run all the International Electrotechnical Commission (IEC) design load cases. This can be a daunting task and doing it one case at a time may lead to errors and inconsistencies.

To make this task a little easier, I've created two Perl scripts to automate it for you. One of them, RunIEC, runs all the discrete wind events generated by IECWind and WindMaker. Its companion, RunNTM, runs a series of normal-turbulence-model simulations. This user's guide will address use of the later.

I originally wrote these scripts to help someone run these cases for a specific turbine, which had proprietary properties. I've converted the scripts to use my AWT-27CR FAST_AD model as an example. You'll need to create your own FAST_AD model to replace mine.

In case you do not know much about Perl, it is an interpreted scripting language with many powerful features. For those folks who have struggled to get DOS batch files to do useful things, Perl is an excellent replacement. As with DOS batch files, you initiate Perl scripts at a command prompt.

I first came across Perl when setting up our web pages. Perl is commonly used to do many of the intelligent things web pages do. It is available for many platforms and it is not very difficult to learn. That makes it an excellent choice to automate many of our boring, routine tasks.

Retrieving Files From The Archive

You should download the RunNTM archive from our web server page http://wind2.nrel.gov/designcodes/runntm/. The file should have a name such as "runntm_v200.exe." Create a RunNTM folder somewhere on your file system and put this file there. You can double-click on it from Windows Explorer or by entering "runntm_v200" at a command prompt with the RunNTM folder as the current directory. This will create some files and folders.

Distributed Files

The files included in the archive of RunNTM are as follows:

ArcFiles.txt	The list of files that are written to the archive.
Archive.bat	The batch file that creates the archive.
Change.log	The list of changes to the RunNTM Perl script.
RunNTM	The Perl script.
RunNTM.cru	The Crunch input file used to find the extreme events.
RunNTM.doc	This user's guide in Word format.
RunNTM.fad	The FAST_AD model of the AWT-27CR turbine.
RunNTM.pdf	This user's guide in PDF format.
AeroData*.dat	The airfoil data files for the AWT-27CR.
Wind\SNwind1.inp	The first part of the SNwind input file.
Wind\SNwind2.inp	The second part of the SNwind input file.

Installing Associated Software

If you have not already done so, you need to install SNwind, FAST_AD, Crunch, and a Perl intrepreter. You can get SNwind, FAST_AD, and Crunch off our web site at http://wind2.nrel.gov/designcodes/. You should install them so that they can run from any folder, but you can specify their locations in the Perl script. You can download a freeware Perl interpreter from ActiveState at http://www.activestate.com/. It should also be installed so that it can be run from any folder. The examples below assume that you can invoke the Perl interpreter by entering "perl" at a command prompt. If you use another name, substitute it into the example below.

Modifying The Perl Script

You need to modify the Perl script before you can run it on your PC. Edit the file named "RunNTM" with your favorite editor, and search for the string "USER" with a case-sensitive search. You will need to change the variables $snwind, $crunch, and $fast_ad. Set them so they point to the SNwind, Crunch, and FAST_AD executables you installed earlier.

For this example, I've set the number of wind speeds and turbulence seeds to two each for a total of four runs so that it won't take a long time to run. It takes about 40 minutes to run the four cases on my 600-MHz PC. You should run at least five wind speeds, but we recommend that you run 10. At least three should be at or above rated wind speed. We also recommend 100 turbulence seeds, with 10 seeds as a minimum. This produces as many as 1000 10-minute simulations. That would take my PC a week or two, so you don't want to do this on a machine you use for your primary work. The nice thing about the script is that you just start it up and let it run. If you can't take that long, reduce the number of wind speeds and/or turbulence seeds. To set these numbers, change the @WindSpeed array and the $NumCases variable.

If you decide to put your wind files in a folder other than the Wind folder that the archive installed on your PC, you will also have to change the $wind_loc variable. If you don't want Crunch to run after all the simulations have run, comment out the Crunch execution statement by putting a pound sign ("#") at the beginning of the line.

If you choose to use a different simulator than FAST_AD, you will need to make many more changes to the script. To do that, you will need to know more about Perl. I learned Perl by stealing other people's code and modifying it to suit my needs. Fortunately, I had George Scott to help me learn the language, but anyone with basic programming skills can master it. George recommended two books (*Programming Perl*, by Larry Wall, et al. and *Effective Perl Programming*, by Joseph Hall and Randal Schwartz) to help me learn the language. I use the first the most. Modifying the script for another simulator will be simulator dependent, so I will not attempt to explain how to do it here. Looking for the strings "fast_ad" and "fastad" will give you an idea where to start.

Running RunNTM

Before using RunNTM, please check the versions of FAST_AD and Crunch you have installed on your computer. If they are newer than your RunNTM archive, you may have to make changes to their input files to bring them up to the current versions. The input files supplied with RunNTM (RunNTM.fad and RunNTM.cru) mention which versions of the programs they are compatible with at the tops of the files.

To test the script, you can use my AWT-27CR model. Try that first before using your own model with RunNTM. Open up a command window in the main RunNTM folder. Simply enter "perl runntm" at the command prompt. The script will loop through a series of wind speeds and turbulence seeds. Within each double loop, it will run SNwind to generate a full-field wind file, then FAST_AD to simulate the turbine. It will do this four times. It takes about 42 minutes to do this on my 600 MHz PC. It generates two files for each simulation. Their root names begin with NTM, then have a two-digit wind speed followed by the letter "u," then a one-digit (or more) number representating the turbulence seed. The two files have extensions "tim" and "sum." These are the time-series results and the FAST_AD summary files.

After the simulations, it will run Crunch and generate the aggregate statistics and the most extreme events of all four cases. These results go into the files "aggregate.sts" and "aggregate.eev."

The Crunch run generates load roses of the blade-root loads and the tower-top loads. It will group the channels for the two roses in two extreme-event tables. These tables can be used to document the extreme events that occurred in all the runs.

After you've run the script with the original model, you'll need to change the SNwind, FAST_AD, and Crunch input files to represent your turbine. The SNwind input file you need to change is "SNwind2.inp," which is found in the Wind folder. The FAST_AD and Crunch input files are found in the main RunNTM folder and are called "RunNTM.fad" and "RunNTM.cru." If you change the output variables in the FAST_AD input file, you will need to modify the Crunch input file to change which channels are analyzed. If you change the wind speeds and/or seeds in the Perl script, you'll need to change the number of data files and their names at the end of the Crunch input file. You may also want to make other changes to the Crunch input file to suit your analysis needs. After you've done all these things, you can re-run the script.

For a real loads document, you should also include other events—especially the discrete wind cases *and* the various fault conditions. You would then want to do one Crunch run with all those simulations as input. To help you with that, you can use the companion script, RunIEC to generate the discrete wind cases. For the fault conditions, you're on your own. If you do this, it will probably make sense to comment out the Crunch call in the Perl script and then run Crunch manually after all cases are run. Look for the string

"USER" to find the line that needs to be disabled in the Perl script.

Known Bugs

- None.

Caveats

The National Renewable Energy Laboratory (NREL) makes no promises about the usability or accuracy of RunNTM, which is essentially a beta code. NREL does not have the resources to provide full support for this program. *You may use RunNTM for evaluation purposes only*.

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I'd also like to thank George Scott for helping me learn Perl.

Feedback

If you have problems with RunNTM, please contact Marshall Buhl. If he has time to respond to your needs, he will do so, but please do not expect an immediate response. Please send your comments or bug reports to:

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